International Complementarities in the Internet: Should Local Access Prices be Regulated?[1]

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Abstract: The Internet can be seen as the convergence of different industries, such as telecommunication, software and media, into an international oligopoly offering complementary products. In most of these industries we have dominant firms, but domestic telecommunication firms providing local access are the only ones facing a restrictive regulatory regime. The other dominant firms are typically US owned. We show that strict regulation of the domestic telecommunication firm may have negative welfare effects for other countries than the USA, particularly if we observe fierce competition in the end-user market.

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1 Introduction

In order to get tied up to the global Internet the end-users must be connected to the local telephone network through an Internet Service Provider (ISP). The ISP in turn provides access to different contents and applications on the Internet through regional and global backbone providers. The Internet is thus often described as the joint supply of several complementary inputs. This is illustrated by Figure 1, where we portray the Internet as a layered network structure with the physical network as one layer, and applications, contents and the service network as other layers. The purpose of this article is to investigate how the complementary within and between the different layers affects the optimal public policy towards the dominant domestic provider of local access.

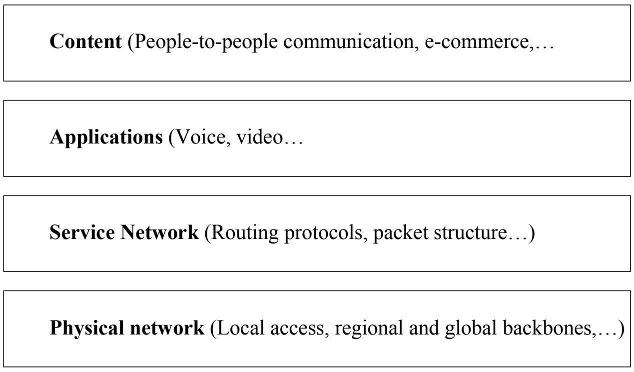

Figure 1: The layered Internet structure

We observe dominant firms in several of the complementary product groups. Apparently, the domestic telecommunication firm still has a dominant position in the local network in many countries.[2] In the global backbone network the five firms MCI

[2]For example, telecommunication incumbents have an installed base of telephone lines that reach almost all households. For residential consumers the main alternative to telephone lines for local access to the Internet is cable-TV-networks, which in Europe are often controlled by the telecommunication incumbents. Since upgrading of the existing telephone lines and cable-TV-lines are the two main alternatives for broadband Internet access, it seems obvious that the telecommunication incumbents will have market power in the segment for local access in Europe also in the future. The differences between the US and Europe regarding alternatives for broadband access are described by Roche *et al.* (2001).

WorldCom, Genuity (formerly GTE), Sprint, AT&T and Cable & Wireless dominate the provision of core Internet backbone service, of which all except the last one are US owned firms.[3] US firms such as Microsoft and Cisco have dominant positions in provision of personal computer operating systems and routers, respectively, while AOL Time Warner seems to gradually achieve a more dominant position in providing content to regional ISPs.[4]

The downstream market for ISPs is generally believed to be more competitive than many other market segments in the telecommunication industry, and is unregulated both in the USA and in Europe (see Cave and Mason, 2001). Domestic telecommunication firms, on the other hand, have historically faced a rather restrictive regulatory regime both on price and quality. A few firms - for example Microsoft and MCI WorldCom - have been challenged by anti-trust authorities, but by and large foreign input suppliers have not been regulated at all.[5]

We thus see that the Internet is a mixture of different complementary products, provided by domestic and foreign firms with market power, where some firms face a restrictive regulatory regime and others are unregulated. In such a setting, what would be the optimal regulation of domestic firms? In order to focus on this question we develop a simple model where we make four basic assumptions.

First, we assume that two ISPs compete á-la Bertrand with differentiated products in the retail market. An assumption of product differentiation seems quite natural, since we to an increasingly larger degree observe that ISPs bundle Internet access with - for example - content from one particular content provider. For high-speed Internet access (broadband) it is likely that some ISPs will offer premium

[3]See Besen *et al.* (2001), Milgrom *et al.* (2000), Crémer, Rey and Tirole (2000), Dogan (2000), Kende (2000), Laffont, Marcus, Rey and Tirole (2001a, 2001b) for more details concerning the role of the Internet backbone providers.

[4]In 2000 Cisco's market share of the total router market was 84 percent (Cave and Mason, 2001), while Microsoft's market share in the market for personal computer operating systems the last year was approximately 90 percent (see e.g. Gilbert and Katz, 2001).

[5]Laffont and Tirole (2000) and Armstrong (2001) give detailed overviews of the theory of access pricing and discussions of the regulation paradigm of the domestic access provider. Cave and Mason (2001) give an extensive overview of the market structure and the regulation policy in different segments of the Internet.

connectivity and content only to their own customers (see Shapiro and Varian (1998) and Crémer *et al.* (2000)). This is often called "a walled garden strategy", and will obviously create product differentiation.

Second, we assume that two upstream firms provide complementary inputs to the two downstream firms. The upstream firms can be interpreted as one domestic provider of local access and one foreign input provider. The foreign input provider may be a global backbone provider (such as MCI WorldCom) or a content provider (such as AOL Time Warner).

Third, we assume vertical separation between the upstream and the downstream firms. In several countries the local access provider is vertically integrated into the retail market, and we also see that firms like MCI WorldCom and AOL Time Warner are active also in the retail markets outside the USA. On the other hand, we do observe that many retailers are independent downstream firms. In such a setting it is more natural to focus on vertical separation than vertical integration. However, it can be shown that our main results are valid also in a setting with vertical integration.[6]

Fourth, we assume that the domestic regulator is able to impose a price cap on the domestic upstream firms (the local access provider). Throughout, we presuppose that the retail ISP-segment and the foreign upstream provider are unregulated. As mentioned above, this corresponds to the existing regulation regime.[7]

In our model we find that the optimal regulatory policy depends crucially on the ability of the regulator and the foreign firm to commit themselves in their price setting. If there is no price commitment at all, neither by the regulator nor by the foreign firm, the best regulatory policy is not to regulate. The reason is that a price cap allows the foreign input provider to set a higher price, resulting in an excessive profit shifting out of the country.

[6]This is shown in Foros, Kind and Sørgard (2001), where vertical separation is compared with partial vertical integration (some firms vertical integrated) and with complete vertical integration (all firms vertical integrated). See also Foros, Kind and Sørgard (2002), where vertical integration is analyzed in a setting with homogenous products and Cournot competition.

[7]Laffont and Tirole (2000, p. 182-183) discuss the assumption of no retail price regulation in telecommunication.

However, it may be beneficial for the regulator to impose a price cap if the foreign firm is able to commit itself. In such a case - which we denote ex post regulation - the foreign firm will be a first-mover and set a relatively low input price. Thereby the regulator is encouraged to set a restrictive price cap on local access, and the price cap will be more restrictive the more differentiated the downstream goods. If the goods are sufficiently differentiated, and the regulator is allowed to set a price below long run marginal costs, this policy is welfare improving. The reason for this is that the price distortion in the end user market is then so large that the country gains from a restrictive price cap, despite the fact that such a policy will shift profits out of the country.

Suppose instead that the regulator is best able to commit itself, which means that it has a first-mover advantage over the foreign firm. In this case - denoted ex ante regulation - a binding price cap will always improve domestic welfare (except in the case where the products are perfect substitutes in the end user market). The regulator sets a binding price cap to pass on to final consumers a price reduction that partly offsets the price distortion in the end user market. But it decides to set a price that exceeds long run marginal costs. Thereby the foreign firm will set a relatively low price on its upstream good, and this reduces the profit shift out of the country.

The paper relates to the literature on strategic trade policy, which is also concerned about international profit shifting.[8] Note, though, that there are some important distinctions between our study and that strand of the literature. In particular, we focus on the effects of a price cap rather than on the effects of subsidies and tariffs. Moreover, we model a setting with complementary inputs produced by one foreign and one domestic firm, respectively. In contrast, strategic trade policy is typically focusing on downstream competition between domestic and foreign firms producing substitutes, and abstract from possible complementarities.[9]

[8]For overviews of the literature on strategic trade policy, see for example Krugman (1989) and Brander (1995).

[9]In his review of the literature, Brander (1995) focused on two modelling approaches: the third-market model, and the reciprocal-markets model. In both models the assumption was that firms produce substitutes.

The article is organized as follows. In the next section we present the model where we compare the market equilibrium with three different regulatory regimes. In Section 3 we offer some concluding remarks.

2 The model

There is one foreign firm, F, and one domestic firm, N, controlling each their essential input. These inputs are supplied to two downstream firms, X_1 and X_2, that sell differentiated consumer goods at prices p_1 and p_2, respectively, in a domestic market.[10] The market structure is shown in Figure 2. We assume that X_1 and X_2 are independent domestic firms, and that they are charged n per unit of the input provided by firm N and f per unit of the input from firm F. Throughout the paper we assume that the only instrument available for the regulator is to regulate the price of local access n. The other input price f and the retail prices p_1 and p_2 are unregulated.

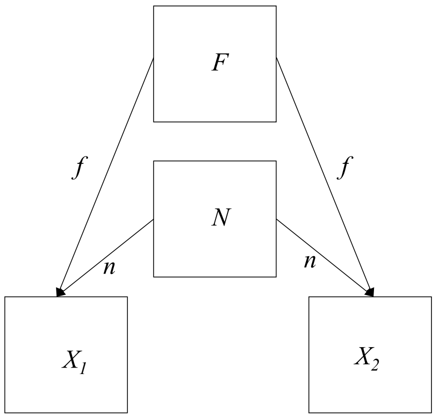

Figure 2: Market structure

The utility function of the consumers is equal to

$$U = x_1 + x_2 - \frac{x_1^2}{2} - \frac{x_2^2}{2} - bx_1x_2, \qquad \text{where } 0 < b < 1. \tag{1}$$

[10] Foros and Hansen (2001), Dogan (2000), and Mason (1999) assume that ISPs offer horizontally differentiated services and compete á-la Hotelling. Their focus is on interconnection quality rather than on access prices.

The parameter b determines the degree of product differentiation. When b is close to 1 the products are (almost) perfect substitutes, while they are (almost) independent products when b is close to 0.

Let p_i be the price of good x_i, where $i = 1, 2$. Since we know that marginal utility is equal to price, we have

$$p_i = 1 - x_i - bx_j,\ i = 1, 2 \quad (i \neq j). \tag{2}$$

Then we have the following demand system for the downstream firms:

$$x_i = \frac{1 - b - p_i + bp_j}{1 - b^2}. \tag{3}$$

Using equations (1) and (2) we can now express consumer surplus, $CS = U - p_1x_1 - p_2x_2$, as

$$CS = \frac{1}{2}x_1^2 + \frac{1}{2}x_2^2 + bx_1x_2. \tag{4}$$

In order to produce the final goods the downstream firms need one unit of a service that is supplied by a domestic monopolist N and one unit of a service that is supplied by a foreign monopolist F. The profit levels of the downstream firms may thus be written as

$$\pi_i = (p_i - n - f)x_i. \tag{5}$$

The marginal costs of the domestic and foreign bottleneck inputs are normalized to zero, which means that the profit levels of these firms are equal to

$$\pi_N = n(x_1 + x_2) \tag{6}$$

and

$$\pi_F = f(x_1 + x_2). \tag{7}$$

Firm N and the two downstream firms are owned by the domestic consumers, and the welfare is given by

$$W = CS + \pi_D, \tag{8}$$

where $\pi_D = \pi_N + \pi_1 + \pi_2$.

In the final stage of the game the two downstream firms compete á-la Bertrand. Inserting for (2) into (5) we find that $\partial\pi_i/\partial p_i = 0$ implies

$$p_i(p_j) = \frac{1-(1-p_j)b+n+f}{2}. \tag{9}$$

Since the downstream firms are symmetric we may omit subscripts, and express equilibrium prices and quantities as

$$p = \frac{1-b+n+f}{2-b} \tag{10}$$

and

$$x = \frac{1-n-f}{(1+b)(2-b)}. \tag{11}$$

It is easily seen from equation (10) that the equilibrium end user prices approach monopoly prices as b approaches 0, and the perfectly competitive prices as b approaches 1.

2.1 Market equilibrium

In the first stage firms N and F simultaneously set n and f, respectively. Solving $\partial\pi_N/\partial n = 0 = \partial\pi_F/\partial f$ we find that

$$n = 1/2 - f/2 \equiv n^*(f) \tag{12}$$

and

$$f = 1/2 - n/2 \equiv f^*(n). \tag{13}$$

These are the upstream firms' reaction functions, and in Figure 3 we have drawn the reaction curves. They have negative slopes, as is what we should expect in a setting with complementary products and price setting.[11]

[11] As shown in Bulow *et al.* (1985), with price setting and complementary products the choice variables are typically strategic substitutes. Then each reaction curve has a negative slope, as is the case in our setting.

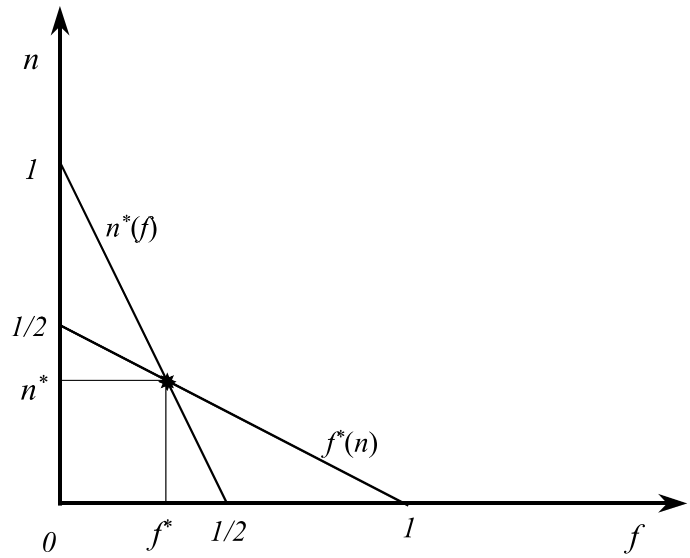

Figure 3: Reaction curves if no regulation

By combining equations (12) and (13) we find that

$$n = f = 1/3, \tag{14}$$

which are denoted by n^* and f^* in Figure 3. Inserting for n and f into (8) and (10) we further have

$$p = \frac{5 - 3b}{3(2 - b)} \tag{15}$$

and

$$W^* = \frac{7 - 4b}{9\,(b + 1)\,(2 - b)^2}. \tag{16}$$

2.2 Price regulation of the domestic upstream good

Let us now introduce regulation. Both in the EU and the US we observe that domestic providers of local access are facing a restrictive price cap on local access. In line with this, we shall assume that the domestic regulator can impose a price cap on the local access price. In principle it is possible that the government can commit itself to a certain price cap *before* the foreign firm sets its price. However, it is also possible that the government acts according to a *per se* rule. If so, it may either be the case that the foreign firm is better able to commit itself than the regulator, or that neither of them are able to commit themselves.[12] In line with this we find it natural to consider three different timings in this section. First we assume that the foreign firm has a first-mover advantage, then that the foreign firm and the regulator set their prices f and n simultaneously, and finally that the regulator has a first-mover advantage.

2.2.1 Ex post regulation

Suppose that the foreign firm is able to commit itself to a certain price f before the regulator chooses n. The regulator sets n such that domestic welfare is maximized. The best the regulator can do is then to set the price n such that the end-user price is equal to domestic marginal costs; $p = f$.[13] This means that n should be chosen according to $p = (1 - b + n + f) \,/\, (2 - b) = f$, or

$$n = -(1 - b)(1 - f) \equiv n^o(f). \tag{17}$$

This equation - which we denote the regulator's reaction function - reflects the fact that the price of the national input should be set lower the less competitive the downstream market. The optimal value of n is thus strictly increasing in b; it equals $-(1-f)$ if the goods are independent, and zero if the goods are homogenous (because there is perfect downstream competition in the latter case).

Note also that $n'(f) > 0$ for $b < 1$. The reason for this is that as long as the firms face downward-sloping demand curves it is inoptimal for the downstream firms to pass over an increase in f one-for-one to the consumers. Some of the cost increase will be covered by the firms, and therefore an increase in f requires a higher n in order to maintain marginal cost pricing. This results in a reaction curve with a positive slope for the regulator, as illustrated in Figure 4. Note that the regulator's reaction curve is qualitatively different from the domestic firm's reaction curve (see Figure 3).

[12]This is in line with what is claimed by Brander (1995, p. 1403): "Most observers find it plausible that governments often have some sort of commitment advantage, but it is important to be alert for circumstances in which the asymmetry may run in the other direction".

[13]This can easily be verified by maximization of the welfare function.

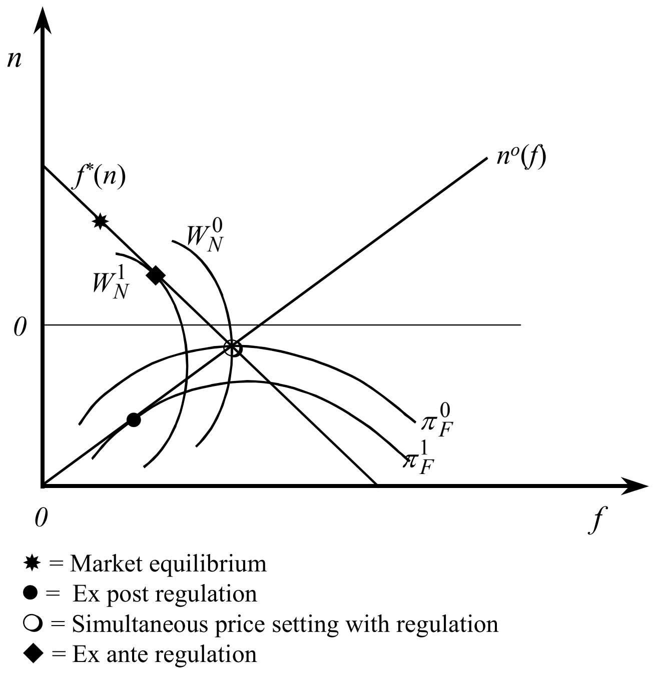

Figure 4: Reaction curves with regulation of the domestic access price

The maximization problem of the foreign firm is to solve $\partial\pi_F/\partial f = 0$ subject to (17). Technically speaking, the foreign firm acts as a Stackelberg leader and chooses the point on the regulator's reaction curve that maximizes its own profit (see Figure 4). The solution to this problem is to set

$$f = 1/2. \tag{18}$$

Inserting for f into (17) we further have

$$n = -(1-b)/2. \tag{19}$$

Since end user prices are equal to domestic marginal costs, it follows that $p = f = 1/2$.

It is easily verified that end-user prices with regulation are lower than without regulation for all $b < 1$. However, the price of the foreign input is higher in the regulatory regime (c.f. equations (14) and (18)). The foreign firm exploits the fact that the regulator will set a low price on the domestic input by increasing its own price. Regulation therefore leads to a higher profit flow from the domestic country to the foreign country, while the profit level falls to zero for the domestic firms.

Inserting for n and f we find that welfare is now equal to:

$$W^{SO} = CS = \frac{1}{4(1+b)}. \tag{20}$$

Comparing equations (16) and (20) we find that a necessary and sufficient condition for ex post regulation to improve welfare is that $b < \frac{2}{9}(5 - \sqrt{7})$. Regulation is therefore beneficial if and only if the goods are sufficiently differentiated. This is illustrated by Figure 5, which shows the difference $W^{SO} - W^*$ as a function of b. The intuition for the shape of this curve is that the downstream firms set a high mark-up when the goods are highly differentiated, in which case the social planner is able to improve welfare by setting a low value for n (high subsidy). If the goods are close substitutes, on the other hand, the high competitive pressure in the downstream market reduces the need for a subsidy. The net effect of a price cap is then to shift profit to the foreign firm.

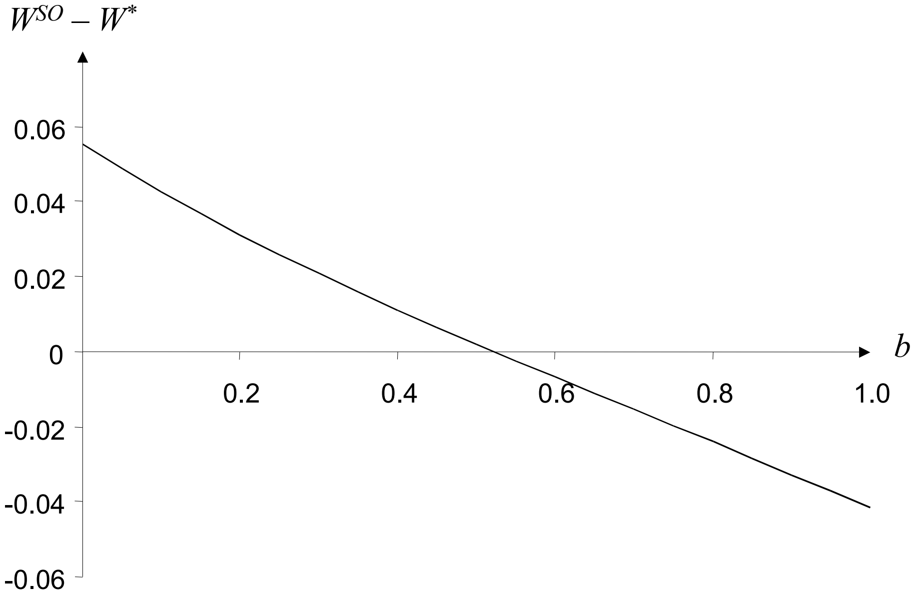

Figure 5: $W^{SO} - W^*$. Ex post regulation

The main insight from the above result is that ex post regulation cannot improve domestic welfare if there is imperfect competition only in the upstream market; there must also be significant market imperfections in the downstream market. In the latter case the gain from reducing the high mark-up in the downstream market outweighs the profit loss out of the country.

However, a regulation regime as described above, where the input from the domestic upstream firm is sold at a price below long-run marginal costs, is rarely observed. The most common regulation regime is instead to allow regulated firms to charge a price which covers their long-run marginal costs, but not to require that they sell at a price lower than this. In the present context this means that the regulator must set a price $n \geq 0$ (while we still have $f = 1/2$). The best ex post regulation is therefore obviously to set $n = 0$. However, this means that the regulator is less able to counterbalance the lack of competition in the downstream market with a low price on the input from the domestic bottleneck owner. In the appendix we therefore show that welfare is always lower with regulation than without regulation if we impose the restriction $n \geq 0$, and that it is equal to

$$W^{SO} = \frac{1}{4} \frac{3 - 2b}{(2 - b)^2 (1 + b)}. \tag{21}$$

To sum up, we have the following welfare effects of ex post regulation:

Proposition 1: *Ex post regulation of the price of the domestic upstream good is welfare improving if and only if the downstream goods are sufficiently differentiated and the regulated domestic input price is set below long-run marginal costs.*

2.2.2 The regulator and the foreign firm set prices simultaneously

Suppose that neither the foreign firm nor the regulator can credibly commit themselves with respect to the prices of the upstream goods. This we may model as if f and n are set simultaneously. The foreign firm and the regulator's reaction functions are as before, c.f. equations (13) and (17). From this we find that

$$f = \frac{b - 2}{b - 3} \tag{22}$$

and

$$n = -\frac{1 - b}{3 - b}. \tag{23}$$

Recall that the foreign firm committed itself to set $f = 1/2$ under a regime with ex post regulation. Given that $n < 0$, though, the reaction function $f(n)$ tells us that the firm would have preferred $f > 1/2$. This can also be seen from Figure 4, where the ex post regulation solution is not on the foreign firm's own reaction curve. However, the foreign firm is aware of the fact that in the ex post regulation regime a higher f would have led to an increase in n in the next stage (because $n'(f) > 0$). When F is not able to commit itself, as is now the case, the foreign firm cannot induce a strict price cap by setting a low value of f. The foreign firm therefore sets a higher price. It thus follows that both f and n increase relative to the regime with ex post regulation (this is easily seen by comparing equations (18)-(19) and (22)-(23)). Evidently, this is detrimental to the profit level of F. It is also detrimental to domestic welfare. The latter is true because the higher value of f means that end user prices increase ($p = f$), while aggregate domestic industry profit is in any case equal to zero. In the appendix we further show that we now have

$$W^{SO} = CS = \frac{1}{(1+b)(3-b)^2}, \tag{24}$$

and that this welfare level is lower than the welfare level in the market equilibrium for all values of b.

If we impose the restriction that the regulator cannot choose any $n < 0$, we have the same results as with ex post regulation and $n \geq 0$. The welfare level in this case is already shown to be lower than in the market equilibrium. We thus have:

Proposition 2: *Let us suppose that the foreign firm and the regulator set the prices of the upstream goods simultaneously. Welfare is then lower than in the market equilibrium.*

By comparing Propositions 1 and 2, we see that regulation improves domestic welfare only if the foreign firm is able to commit itself with respect to the price that it charges. The reason is that the foreign firm will use a first-mover advantage to set a relatively low input price (in order to encourage the regulator to set a low input price as well). This implies that the profit loss out of the country is more limited, and the end-users gain from lower prices.

2.2.3 Ex ante regulation

Suppose next that the regulator is able to commit itself with respect to the local access price. In this case it is optimal for the regulator to use a less strict regulation of n than in the previous cases we have considered. The reason is that an increase in the price of the domestic upstream good will reduce the price of the foreign upstream good. Formally, the regulator solves

$$\begin{aligned} W^{SO} &= \max_{n} (CS + \pi_D) \\ \text{s.t. } f(n) &= \frac{1}{2}(1-n). \end{aligned}$$

Technically speaking, the regulator chooses the point on the foreign firm's reaction curve that maximizes domestic welfare (see Figure 4). Since the downstream firms are symmetric ($x_1 = x_2$), we have

$$\frac{dCS}{dn} = 2x(1+b)\frac{dx}{dn} \tag{25}$$

and

$$\frac{d\pi_D}{dn} = 2\left[1 - 2x(1+b)\right]\frac{dx}{dn} - 2\left[f\frac{dx}{dn} + x\frac{df}{dn}\right], \tag{26}$$

where

$$\frac{dx}{dn} = \frac{\partial x}{\partial f}\frac{df}{dn} + \frac{\partial x}{\partial n}. \tag{27}$$

An increase in n reduces the output from the downstream firms, and the resulting loss of domestic revenues from each downstream good is shown by the first square bracket in (26). Differentiating equation (11) we find that $\partial x/\partial n = -1/\left[(1+b)(2-b)\right]$, while from the reaction function of Firm F we have that $df/dn = -1/2$. Since $\partial x/\partial f = \partial x/\partial n$ we thus see that the total change in x is equal to $dx/dn = -1/\left[2(1+b)(2-b)\right] = (1/2)\partial x/\partial n$. The negative quantity effect of increasing n is thus only half as large with ex ante regulation as when the regulator cannot commit itself (in which case $\partial f/\partial n = 0$).

An increase in n also reduces demand and the equilibrium price of the foreign downstream good. The second square bracket in (26) thus shows the size of the domestic cost saving for each downstream good.

Setting $dW^{SO}/dn = 0$, and inserting for f, dx/dn and $\partial f/\partial n$ we find that

$$W^{S0} = \frac{1}{(1+b)(5-2b)}, \tag{28}$$

and that the prices of the upstream goods are given by

$$n = \frac{1}{5-2b} \tag{29}$$

and

$$f = \frac{2-b}{5-2b}. \tag{30}$$

Note that n is now positive, but lower than the price that the domestic upstream monopolist would prefer as long as $b < 1$. Therefore f is also in this case higher in the regulated economy than in the market equilibrium. This is illustrated in Figure 4. However, welfare is higher (c.f. equations (16) and (28)). We thus have

Proposition 3: *If $b = 1$, the optimal ex ante regulation of the domestic upstream good is no regulation. If $b < 1$, the regulator sets n such that $n^* > n > 0$, which results in $f > f^*$ and improved domestic welfare.*

If the downstream goods are differentiated it is thus welfare enhancing for the regulator to partly correct the distortion in the downstream market by setting a price cap on the domestic access price. Note, however, that this is not a very restrictive regulatory regime. The regulator will always set a price that exceeds marginal costs. If it had set a more restrictive price cap, the profit shift to the foreign country would have outweighed the gain for domestic consumers from lower prices.

Finally, note that

Corollary 1: *Independent of the timing of the game, the regulated price of the domestic upstream good is increasing in b.*

The intuition for this corollary is simply that a high value for b means that the downstream market is relatively competitive, making it less imperative with a low value on n.

Using Figure 4, we can compare the input prices in the different regulatory regimes. We see that in all the three regulatory regimes the foreign firm sets a higher prices than in the regime with no regulation. This illustrates that the foreign firm exploits the fact that regulation in all three cases leads to a binding price cap on the domestic upstream good.

3 Concluding remarks

The Internet can be seen as the convergence of different industries like telecommunication, software, and media into an international oligopoly, where the end-user is offered a bundle consisting of complementary products such as access to local and global networks, software, and content. In several of the industries we observe dominant firms. Except for local access, where the domestic telecommunication firm is the dominant firm, these dominant firms are typically large US owned firms. Last, but not least, there is a striking asymmetry concerning regulatory policy. While domestic providers of local access have faced a restrictive regulatory regime, few other dominant firms in the Internet industry have been regulated. This raises the question: Will a restrictive regulation of local access still make sense? We find that in some cases no regulation is the optimal regulation, but that the optimal policy depends crucially on characteristics of the industry, such as the degree of product differentiation, and the parties' ability to commit themselves.

We conjecture that the problem on which we have focused will become even more important in the future. When the Internet was established, the payment for using the Internet was typically made to gain access to the local telecommunication provider. A few years ago the Internet backbone providers started to charge ISPs for access to the global network, which is needed for complete access to the Internet. Content providers are gradually becoming more concerned about the low revenues that they receive for their services.[14] The providers of products that are comple-

[14]In Kahin and Varian (2000) there are numerous examples of business models for content providers on the Internet. For example, Mings and White (2000) discuss how news agencies can earn profits from online news.

mentary to local access are demanding a share of the revenues generated on the Internet.[15] This is exactly the setting we are analyzing, where a domestic regulator of domestic access must take into account the fact that regulation can shift profits from the domestic access provider to other providers of complementary products, often large, foreign firms.

If foreign providers of inputs that are complementary to local access do not have market power, there is no reason for the domestic regulator to take profit shifting into account. This illustrates that international cooperation on antitrust policy that curbs market power for large, international firms might in theory be a better solution than a more liberal domestic regulatory policy. However, it remains to be seen whether international cooperation on antitrust policy is a realistic solution, since the host country of the dominant firms typically will have conflicting interests to those of other countries.

[15] In both Sweden and Norway content providers are organized in alliances, and they argue that they should have a larger share of the revenue generated on the Internet. In Sweden they have threatened to introduce a filter that can monitor the Internet traffic. If an Internet surfer is connected through an ISP that has no agreement with the content provider, he or she will be denied access to the content provider. (see http://rigg.aftenposten.no/nyheter/okonomi/d221464.htm).

4 References

Armstrong, M. (2001): 'The Theory of Access Pricing and Interconnection', in Cave, M., S Majumdar, and I. Vogelsang (eds.): *The Handbook of Telecommunications Economics*, North Holland, forthcoming.

Besen, S., P. Milgrom, S. Mitchell, and P. Srinagesh (2001): 'Advances in Routing Technologies and Internet Peering Agreements', *American Economic Review, Papers and Proceedings*, 91, 292-296.

Brander, J. A. (1995): 'Strategic Trade Policy', Chapter 27 in G. E. Grossman and K. Rogoff (eds.): *Handbook of International Economics*, Volume 3, North-Holland.

Bulow, J., J. Geanakoplos and P. Klemperer (1985): 'Multimarket Oligopoly: Strategic Substitutes and Complements', *Journal of Political Economy*, 93: 488-511.

Cave, M. and R. Mason (2001). The Economics of the Internet: Infrastructure and Regulation, *Oxford Review of Economic Policy*, 17(2): 188-210.

Crémer, J., P. Rey and J. Tirole (2000): 'Connectivity in the Commercial Internet', *Journal of Industrial Economics*, XLVIII: 433-472.

Dogan, P. (2000): 'Vertical Integration in the Internet Industry', manuscript, IDEI, Toulouse.

Foros, Ø., H. J. Kind and L. Sørgard (2001): 'International Complementarities in the Internet: Should Domestic Local Acces Prices be Regulated?', working paper 33/2001, Institute for Research in Economics and Business Administration.

Foros, Ø., H. J. Kind and L. Sørgard (2002): 'Access Pricing, Quality Degradation, and Foreclosure in the Internet', *Journal of Regulatory Economics,* forthcoming.

Foros, Ø. and B. Hansen (2001): 'Competition and Compatibility among Internet Service Providers', *Information Economics and Policy*, 13(4): 411-425.

Gilbert, R.J. and M.L. Katz (2001): 'An Economist's Guide to US v. Microsoft', *Journal of Economic Perspectives*, 15: 25-44.

Laffont, J. J., S. Marcus, P. Rey and J. Tirole (2001a): 'Internet Interconnection and the Off-Net-Cost Pricing Principle', manuscript, IDEO, Toulouse.

Laffont, J. J., S. Marcus, P. Rey and J. Tirole (2001b): 'Internet Peering', *American Economic Review, Papers and Proceedings*, 91, 287-291.

Laffont, J. J. and J. Tirole (2000): *Competition in Telecommunication*, MA: The MIT Press.

Kahin, B. and H. Varian (eds.) (2000): *Internet Publishing and Beyond*, MA: The MIT Press.

Kende, M. (2000): 'The Digital Handshake: Connecting Internet Backbones', OPP WP 32/00, FCC.

Krugman, P. (1989): 'Industrial Organization and International Trade', Chapter 20 in R. Schmalensee and R. Willig (eds.): *Handbook of Industrial Organization*, Volume 2, North-Holland.

Mason, R. (1999): 'Compatibility between Differentiated Firms with Network Effects', Discussion Paper no. 9909, University of Southampton.

Milgrom, P., S. Mitchell, and P. Srinagesh (2000): 'Competitive Effects of Internet Peering Policies', in Vogelsang, I. and B.M. Compaine (eds): *The Internet Upheavel*, The MIT Press.

Mings, S. M. and P. B. White (2000): 'Profiting from Online News: The Search for Viable Business Models', in Kahin, B. and H. Varian (eds.) (2000): *Internet Publishing and Beyond*, MA: The MIT Press.

Roche, P.J., J.C. Garcia, J. Wilkins, S.C. Beardsley, P. Edin, P. Loulou, and W.A. Mohn (2001): 'Pipe War: Which Broadband Technology will win the Race for Homes and Offices?', *The McKinsey Quarterly*, no. 1, 178-193.

Shapiro, C. and H. Varian (1998): *Information Rules: A Strategic Guide to the Network Economy*, Harward Business School Press, Boston, Massachusetts.

5 Appendix

Proof of equation (21)

With ex post regulation and the restriction $n \geq 0$ we find that $p = (3-2b) \,/\, [2(2-b)]$

and $x = 1/\left[2(1+b)(2-b)\right]$. We thus have

$$\begin{aligned}\pi_1 &= \pi_2 = \frac{1}{4}\frac{1-b}{(2-b)^2(1+b)} \text{ and} \\ CS &= \frac{1}{4(2-b)^2(1+b)}.\end{aligned}$$

Using that $\pi_N = 0$, and inserting for π_1, π_2 and CS, we find (21). The difference between welfare in the regulated and the unregulated economy (equations (21) and (16)) is then equal to

$$W^{SO} - W^* = -\frac{1}{36}\frac{1+2b}{(2-b)^2(1+b)} < 0.$$

Proof of equation (24)

When the foreign firm and the regulator set the prices f and n simultaneously, we find that $x = 1/\left[(1+b)(3-b)\right]$. Inserting for this into equation (4) we find equation (21). The difference between welfare in the regulated and the unregulated economy (equations (21) and (16)) is then equal to

$$W^{SO} - W^* = -\frac{1}{9}\frac{(3-2b)(9+2b(b-4))}{(1+b)(3-b)^2(2-b)^2} < 0.$$